

Assignment5

Arbuda Sivani Majeti

11/06/2022

```
library(lpSolve)
```

```
## Warning: package 'lpSolve' was built under R version 4.1.3
```

```
library(lpSolveAPI)
```

```
## Warning: package 'lpSolveAPI' was built under R version 4.1.3
```

Maximize $Z = P - 6C - 3D$, where

P = total (discounted) profit over the life of the new products, C = change (in either direction) in the current level of employment, D = decrease (if any) in next year's earnings from the current year's level.

TOTAL PROFIT $P = 20(x_1) + 15(x_2) + 25(x_3)$ EMPLOYMENT LEVEL $= 6(x_1) + 4(x_2) + 5(x_3) = 50$ EARNINGS NEXT YEAR $= 8(x_1) + 7(x_2) + (5x_3) \geq 75$

CONSTRAINTS: $6x_1 + 4x_2 + 5x_3 + y_{1n} - y_{1p} = 50$; $8x_1 + 7x_2 + 5x_3 + y_{2n} - y_{2p} = 75$;

OBJECTIVE FUNCTION (MAXIMIZE): max: $20x_1 + 15x_2 + 25x_3 - 6y_{1n} - 6y_{1p} - 3y_{2n}$

1. Define y_{1+} and y_{1-} , respectively, as the amount over (if any) and the amount under (if any) the employment level goal. Define y_{2+} and y_{2-} in the same way for the goal regarding earnings next year. Define x_1 , x_2 , and x_3 as the production rates of Products 1, 2, and 3, respectively. With these definitions, use the goal programming technique to express y_{1+} , y_{1-} , y_{2+} and y_{2-} algebraically in terms of x_1 , x_2 , and x_3 . Also express P in terms of x_1 , x_2 , and x_3 .

2. Express management's objective function in terms of x_1 , x_2 , x_3 , y_{1+} , y_{1-} , y_{2+} and y_{2-} .

Defining Variables: x_1 = production rate of Product 1 x_2 = production rate of Product 2 x_3 = production rate of Product 3 $y_{1p} = y_{1+}$ = Amount Over $y_{1n} = y_{1-}$ = Amount Under y_{2p} and y_{2n} = Same way for the goal regarding earnings next year P in terms of x_1, x_2 and x_3 and Objective function in terms of $x_1, x_2, x_3, y_{1p}, y_{1n}, y_{2p}, y_{2n}$

```
EMAX <- read.lp("EMAX.lp")
print(EMAX)
```

```
## Model name:
##      x1      x2      x3      y1p      y1n      y2n      y2p
## Maximize    20    15    25     -6     -6     -3      0
## R1         6     4     5     -1      1      0      0 = 50
## R2         8     7     5      0      1      0     -1 = 75
## Kind        Std      Std      Std      Std      Std      Std
## Type        Real     Real     Real     Real     Real     Real
## Upper        Inf      Inf      Inf      Inf      Inf      Inf
## Lower         0       0       0       0       0       0
```

```
EMAX_table <- matrix(c("Total Profit", "Employment level", "Earnings Next Year",
                        20,6,8,
                        15,4,7,
                        25,5,5,
                        "Maximize", "=50", ">=75",
                        "Millions of $","Hundreds of Employees","Millions of $"), ncol=6,

colnames(EMAX_table) <- c("Factor", "Product1", "Product2", "Product3", "Goal", "Units")

as.table(EMAX_table)
```

```
##      Factor      Product1 Product2 Product3 Goal      Units
## A Total Profit    20      15      25      Maximize Millions of $
## B Employment level 6       4       5       =50      Hundreds of Employees
## C Earnings Next Year 8       7       5       >=75      Millions of $
```

3. Formulate and solve the linear programming model. What are your findings?

```
solve(EMAX)
```

```
## [1] 0
```

```
get.objective(EMAX)
```

```
## [1] 225
```

```
get.constraints(EMAX)
```

```
## [1] 50 75
```

```
get.variables(EMAX)
```

```
## [1] 0 0 15 25 0 0 0
```

Findings:

$x_1 = 0$ $x_2 = 0$ $x_3 = 15$ $y_{1p} = 25$ $y_{1n} = 0$ $y_{2p} = 0$ $y_{2n} = 0$

Product1 - 20Units Product2 - 15Units The above mentioned products cannot be produced as the solution is 0. Product3 - 15Units The above mentioned product can be produced by the firm to achieve the Maximum profit

Number of employees can only be 5000 but, the firm exceeded it by 25 employment levels causing 25000 employees to be penalized and 150 units to be deducted. While defining the variables, I stated that y_{1p} and y_{2n} will be the Amount over or under over the upcoming years and when we see our solution it is a 0 from the current level and this indicates that there will be no increase or decrease in the earnings and it shall remain constant next year. Earnings goal for the upcoming year has been met. From the objective function it is clear the firm will have a 225 million dollars as the maximum profit